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Intelligent Healthcare Monitoring System Using IOT and Artificial Intelligence: For Baby Neuro Care

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Abstract
This paper outlines a design for an intelligent baby health monitoring system based on IoT and AI to guarantee the safety of babies. Since babies cannot communicate their physical state, it is necessary to conduct constant monitoring of their physiological parameters to identify any health problems as soon as possible.
In the system developed, several physiological parameters of the baby are measured including body temperature, heart rate, and oxygen saturation by connecting DS18B20 and MAX30100 sensors to Raspberry Pi Pico. Data obtained from sensors is transferred via Wi-Fi to Thing Speak Cloud and can be monitored remotely in real-time.
The next step involves applying AI to the obtained sensor data to spot any abnormalities indicating potential health risks. Besides, a camera module is used to monitor the position of the baby during sleep and identify any positions which could pose certain risks to the baby's health.
All historical health data about the baby is kept in the cloud database. In case of identifying any abnormalities in the health of the baby, an alert message will be sent via a GSM module.

Keywords: Baby Monitoring, IoT, ESP8266, MAX30100, Heart Rate, SpO_2, Temperature, GSM Alerts

1. Introduction

Continuous monitoring of infant health is vital since infants can suddenly be exposed to various health problems due to the nature of babies' sensitivity to health issues. Babies are unable to communicate or indicate when something goes wrong, which makes continuous monitoring of vital body parameters necessary to maintain the child's well-being.
Parents or caregivers usually perform traditional monitoring techniques that can delay the discovery of any health problems of babies. In today's technological world, it is quite possible to develop an advanced healthcare monitoring system thanks to the fast development of IoT and AI. This monitoring system utilizes a Raspberry Pi Pico microcontroller that is connected to biomedical sensors, collects all data related to the baby's physiological processes, and sends it to a cloud platform via Wi-Fi. Thus, data storage

and analysis are performed by a cloud service.

The monitoring system keeps records of previous and current health parameters. Apart from sensor-based monitoring, this system also uses a camera module for recording infants' activities and sleeping positions. Sensor and visual data are processed with AI algorithms, which help detect any abnormalities in babies' condition or sleeping positions. In case of any health problem, notification messages will be sent to caregivers or parents via a GSM module. Thus, the development of IoT, AI, cloud computing, and continuous monitoring technologies allows creating a very effective and efficient healthcare monitoring system.

2. Related Work

There have been recent developments in the Internet of Things (IoT), making significant contributions to enhancing baby monitoring systems. Several baby monitoring systems exist, which incorporate microcontrollers such as ESP8266 and ESP32 for environmental parameter sensing such as temperature, humidity, and motion, creating a healthy atmosphere for the baby. Apart from this, health monitoring wearables have been designed, which involve sensors like MAX30100, capable of monitoring the vital physiological factors like the heart rate and SpO2. The monitoring systems ensure health issues in infants are detected in the early stages.

Apart from this, SMS notification systems based on GSM modules have been adopted, which provide alerts to parents through SMS in case of emergencies. There are several sophisticated baby monitoring systems which also include sound sensors to detect cries of the infant and employ machine learning algorithms to differentiate between normal and distress states. However, there are some disadvantages in the existing baby monitoring systems, such as the limitation of single-parameter monitoring, inadequate technology integration, expensive commercial baby monitors, and the need for consistent internet connectivity. Hence, there is a need for developing a baby monitoring system with multiple parameters, which guarantees reliable real-time alerts and enhanced infant safety.

3. Methodology

The suggested AI-powered Baby Health Care Monitoring System keeps track of the infant's health indicators, sleeping postures, and the environment using sensors, Internet of Things (IoT) connectivity, and artificial intelligence algorithms. It also tracks health indicators of infants in the past and provides visual monitoring in real-time for the parents.

The approach can be described through the following steps: Data acquisition, Data processing, Cloud transfer, Artificial intelligence analysis, Detection of sleeping posture, Live monitoring, Analysis of historical data, and Alert generation.

- **Data Acquisition:** In the first step, the biometric sensors detect the physiological parameters of the infant in real-time.
- The DS18B20 temperature sensor detects the temperature of the baby's body.
    - The MAX30100 sensor detects the heart rate and blood oxygen level (SpO_2).

3. Data Processing

Analog signals from the sensors are received by the Arduino microcontroller to be filtered and converted into digital values for processing and transmission.

4. Data Transmission to Cloud

The processed data is transferred to the IoT cloud platform Thing Speak using the WeMo's D1 Mini Wi-Fi module.

Thing Speak carries out the following tasks:

- Saves the information about the temperature and pulse of the baby
- Shows real-time graphs
- Stores previous records

Parents and doctors can see historical information about the baby's health parameters to assess the trends.

This is the text you should include in your Methodology chapter concerning Raspberry Pi Pico.

Raspberry Pi Pico Based Data Acquisition

In the project, the Raspberry Pi Pico serves as a data acquisition device interfacing sensor. The RPi Pico acquires physiological data from the DS18B20 sensor measuring temperature, and from the MAX30100 that measures the baby's heart rate and SpO_2 saturation. Then, the acquired data undergoes signal processing and filtering on the Raspberry Pi Pico for reliable readings.

Next, the Raspberry Pi Pico sends the acquired information to the communication module via serial communication. Thereafter, the information is sent to the IoT cloud using the Wi-Fi connection. Information is saved, analysed and shown on real-time graphs in the cloud.

Using Raspberry Pi Pico will increase stability of data acquisition and processing, ensuring continuous monitoring of the health of infants. This data is further used for identifying health abnormalities and deviations from proper lying positions by AI algorithms.

5. AI-Based Health Analysis

The artificial intelligence algorithm will analyze the health data from the sensors attached to the baby. The AI algorithm will compare the real-time data with normal infant health data and identify abnormalities in health, which include but are not limited to the following:

- Fever
- Low oxygen saturation
- Irregular heartbeat patterns

The AI system can also be used to monitor previously recorded data on Thing Speak and can help in identifying any abrupt health changes in the infant.

6. AI-Based Sleeping Position Detection

Sleeping posture plays a very important role in ensuring safety for the babies. The ESP32 camera can be used to take photos of the baby's sleeping posture.

These images can then be analysed using AI-based image processing algorithms and classified according to:

- Back-sleeping posture
- Side-sleeping posture
- Face-down posture
- Covered face or breathing obstruction

In case the baby is lying in an unsafe sleeping posture, the AI algorithm can detect it and send an alert to the parents.

7. Live Video Monitoring

Another functionality provided by ESP32 camera will be live video monitoring. Using this function, parents can view the real-time video of the baby's surroundings using the ESP32 camera.

8. Historical Data Analysis

Previous values of temperature and heart rate are stored on the cloud database of the IoT platform. Previous values help caregivers trace trends in the health condition of the child.

Stored data can be represented in graphical and chart forms, which will make it easier for medical professionals and parents to understand their child's health conditions.

9. Alert and Notification System

In case of detecting any abnormalities in the health indicators of the child or an improper sleep position of the baby, the communication module sends alerts to the parents/caregivers using GSM technology.

10. Continuous Monitoring

The process is repeated continuously as far as collecting data, storing it in cloud databases, analysing with AI, and sending alerts are concerned. Thus, the health parameters of the child, his/her sleep position, and surrounding environment are constantly monitored

11. Results And Analysis

The system was analyzed using a live hardware-based approach with the aid of a microcontroller, together with multiple sensors to determine how effective the system is at monitoring the health conditions of infants. Various test cases were designed based on parameters such as temperature, heartbeat, and oxygen levels. When under normal conditions, the LCD display was stable and free from alerts showing that the baby is fine. However, introducing anomalies such as rise in temperature or reduction in oxygen levels, resulted in the detection of the anomalies and alerts. Monitoring of variations in heart rate was done effectively, with constant values of heartbeat and SpO_2 levels obtained with the help of the MAX30100 sensor. Alert messages were immediately sent out to relevant caregivers via the GSM module whenever parameters exceeded their predefined threshold values. Communication among system components worked well as there was no delay in data transmission and alert sending process. Small fluctuations in the results recorded were caused by movements and positioning of the sensors. The response time of the system was very fast and efficient. In summary, the monitoring system has worked effectively and efficiently for real-time analysis.

Observation Summary:

- The system measured temperature, heart rate, and oxygen level with accuracy using the MAX30100 sensor, providing accurate readings under normal circumstances.
- The system was able to detect abnormal values of temperature, SpO_2, and heart rate and raise alarms right away.
- GSM module provided reliable transmission of alarms without any considerable delay.
- Small variations owing to body movements were noted, but still, the performance of the system was effective enough.

In conclusion, the design is quite efficient for improving infant monitoring in real time, increasing awareness on the part of caregivers, facilitating timely notification, and ensuring increased safety and rel-

iability when handling babies.

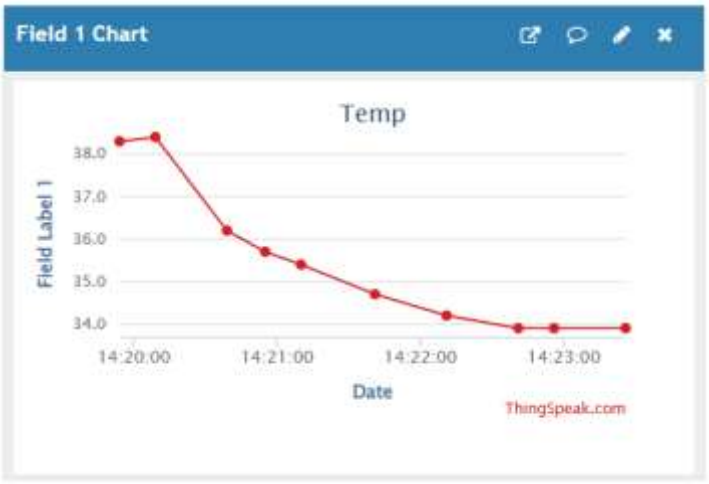

Fig. 1: Temperature Variation with Time

Fig. 2: Heart Rate Monitoring Analysis

Fig. 3: SpO2 Level Monitoring Over Time

12. Some Common Mistakes

Some common mistakes may occur during the development and testing of the suggested baby monitoring system which might impact its overall functioning.

- **Improper placement of sensors:** Incorrect positioning of the sensors might cause faulty measurement of temperature, heart rate, and SpO_2 via the MAX30100 sensor.
- **Delayed alert transfer:** There might be delays in delivering alerts to caregivers due to network or GSM problems.
- **Faulty threshold limits:** Excessive or insufficient setting of threshold values will either generate false alerts or ignore emergencies.
- **Fluctuating measurements:** The baby's movement and environmental conditions might cause variations in readings, hence compromising accuracy.
- **Unsteady power supply:** Fluctuations in the power supply might impact the sensor's functioning.

Conclusion

In this research, we have designed an AI-Based Baby Health Care Monitoring System which combines IoT technology with Artificial Intelligence. It continuously monitors the health and safety of the baby based on various physiological parameters such as body temperature, heart rate, and blood oxygen level. Sensors such as DS18B20 and MAX30100 are used to record all these health parameters. Then these physiological signals are analysed using a microcontroller and sent to the cloud platform called Thing Speak using the WeMo's D1 Mini Wi-Fi module.

Further, our proposed system utilizes ESP32 camera modules for performing live monitoring of the baby as well as its sleeping position. AI-based algorithm detects dangerous or risky sleeping postures using this video feed from the camera to ensure the safety of the baby. Moreover, our system also maintains the record of health history of the baby by storing the information of temperature and heart rate into cloud server.

In case any of these parameters show some unusual values like high temperature or irregular heartbeat, an immediate notification is sent to parents via GSM communication module.

To conclude, the proposed AI-Based Baby Health Care Monitoring System is very cost-effective as well as reliable. The combination of IoT technology, cloud-based storage, AI-based health analysis system, video monitoring system, and alert notification system in one system increases its efficiency significantly to ensure safety and health of babies.

Future Work

Currently, the existing technology is very reliable in real-time monitoring of vital signs of an infant and provides cost-effective solutions. There is still room for improvements and expansions in the system. Future enhancement of the system involves installing a mobile application through which parents can monitor baby health regardless of their location while receiving graphical representation of their readings. Future improvements could involve the use of advanced sensors, which would not only detect temperature, heart rate, and breathing, but also respiration rate and movements. Artificial intelligence can further enhance functionality of the devices by helping in prediction of potential health threats and risk management. Cry detection could also be incorporated to increase responsiveness to the baby needs.

Another future improvement includes miniaturization of the device to be installed as part of a wearable clothing piece for convenience. Further development should focus on improvement of the power

consumption, adding batteries, and other energy saving techniques. The integration of GSM and IoT technologies into a communication channel will provide constant alerts to parents without delays or disruptions.

All these improvements and enhancements will make future devices even more advanced and user-friendly.

References

1. A. Bhaga and V. Madisetti, *Internet of Things: A Hands-On Approach*, 1st ed., Universities Press, 2014.
2. M. Schwartz, *Internet of Things with ESP8266*, Birmingham, U.K.: Packt Publishing, 2016.
3. Maxim Integrated, "MAX30100 Pulse Oximeter and Heart-Rate Sensor IC for Wearable Health," Datasheet, 2014.
4. IEEE, "IoT-Based Health Monitoring Systems: A Review," *IEEE Xplore Digital Library*, 2018.
5. World Health Organization (WHO), "Guidelines on Infant Health and Monitoring," WHO Press, 2020.
6. S. Patel, H. Park, P. Bonato, L. Chan, and M. Rodgers, "A Review of Wearable Sensors and Systems with Application in Rehabilitation," *Journal of NeuroEngineering and Rehabilitation*, vol. 9, no. 21, 2012.
7. J. Gubbi, R. Buyya, S. Marusic, and M. Palanisami, "Internet of Things (IoT): A Vision, Architectural Elements, and Future Directions," *Future Generation Computer Systems*, vol. 29, no. 7, pp. 1645–1660, 2013.
8. D. Ndzi, A. Haridas, and Y. Yang, "Wireless Sensor Network for Monitoring Infant Health Conditions," *International Journal of Sensor Networks*, vol. 19, no. 3, pp. 145–152, 2015.
9. H. Alemdar and C. Ersoy, "Wireless Sensor Networks for Healthcare: A Survey," *Computer Networks*, vol. 54, no. 15, pp. 2688–2710, 2010.
10. S. Rajasekaran and G. A. Pai, "IoT Based Smart Infant Monitoring System," *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, vol. 8, no. 6, pp. 2278–3075, 2019.
11. K. Ashton, "That 'Internet of Things' Thing," *RFID Journal*, 2009.
12. A. Pantelopoulos and N. G. Bourbakis, "A Survey on Wearable Sensor-Based Systems for Health Monitoring," *IEEE Transactions on Systems, Man, and Cybernetics*, vol. 40, no. 1, pp. 1–12, 2010.
13. P. Gope and T. Hwang, "BSN-Care: A Secure IoT-Based Modern Healthcare System Using Body Sensor Network," *IEEE Sensors Journal*, vol. 16, no. 5, pp. 1368–1376, 2016